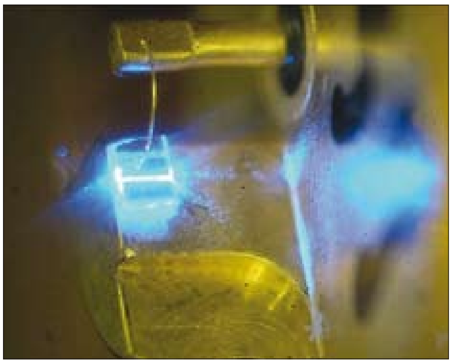
NON-POLAR DEVICES

Rohm nears green laser diode target

Rohm is closing in on its goal of making a non-polar green laser diode for laser TV. The company has pushed the peak emission wavelength of its continuous-wave (CW) lasers to 481 nm, which is 39 nm short of its ultimate target. Slightly longer-wavelength GaN-based lasers have been built with conventional polar GaN, but the 488 nm leading effort by Nichia is now under threat, thanks to Rohm's rapid progress.

Rohm's recent increase in lasing wavelength has come through improvements in the structure's optical confinement, reduced mirror loss and a cut in operating voltage.



NICHIA

Rohm has fabricated blue-green CW non-polar lasers with a peak output power of more than 20 mW.

The researchers grew their devices by MOCVD on freestanding non-polar *m*-plane GaN substrates. The laser structures featured AlGaN cladding, InGaN wave-guiding layers, an AlGaN electron-blocking layer and a two-period InGaN multiple quantum well.

Edge emitters were fabricated from these epiwafers that had stripe widths of 1.5–4.0 µm and 400 µm long cavities. Distributed Bragg reflectors increased the laser's facets to an estimated 70 and 99%.

The lasers produced a CW output power of more than 20 mW, a threshold current density of 6.1 kA/cm^2 and a slope efficiency of 0.49 W/A. This is more than twice the maximum output power of conventional *c*-plane lasers operating at similar wavelengths, which are less than half as efficient.

Efforts are now focusing on increasing emission efficiency at longer wavelengths and reducing contact resistance at the metal–GaN interface, which will lead to lower operating voltages.

Journal reference

K Okamoto *et al.* 2008 *Appl. Phys. Express* **1** 072201.

GAN ICS

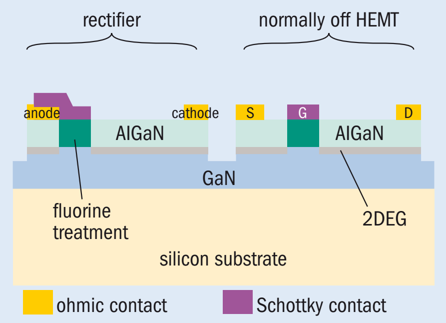
Researchers unite HEMTs and rectifiers

GaN rectifiers and normally off HEMTs can now be built on the same chip, thanks to Kevin Chen and his team at Hong Kong University of Science and Technology.

According to Chen, this breakthrough in GaN power electronic ICs will enable the single-chip implementation of GaN-based switch-mode power converters. This includes buck and boost converters that can step up and step down voltages, respectively.

Unifying rectifiers and HEMTs on the same chip has been a major challenge for GaN developers, because the epitaxial structures of PIN rectifiers and low on-resistance Schottky barrier diodes are incompatible with this type of transistor.

Chen's team has overcome this problem with a lateral field-effect rectifier (LFER). This features a Schottky-gate-controlled two-dimensional electron gas channel, which is in ohmic contact with the cathode and anode (see figure). The Schottky gate and anode are tied together, and the turn-on voltage is determined by the threshold voltage of the channel rather than the Schottky barrier.



Fabrication of the rectifier involves the incorporation of fluorine ions under the Schottky contact by carbon tetrafluoride plasma treatment. This pinches off the conduction path and enables the rectifier to have a reverse blocking capability.

A Nitronex $Al_{0.26}Ga_{0.74}N$ HEMT wafer on a silicon (111) substrate was used to create the IC, which features a LFER with a drift length of 10 µm. This has a forward turn-on voltage of 0.63 V at 100 A/cm^2, a breakdown voltage of 390 V at 1 mA/mm and a specific on-resistance of 1.4 mΩ cm^2. The low turn-on voltage cuts power consumption in the on state and leads to higher power efficiencies when LFERs are used in power converters.

SiC is another promising material for power applications, but Chen believes that GaN devices have the potential to deliver a lower on-resistance, which boosts efficiency.

"In addition, AlGaN/GaN HEMTs feature much higher switching frequencies, which enable size reduction of passive reactive components," said Cheng. This is important because it should lead to compact, lightweight power converters.

Journal reference

W Chen *et al.* 2008 *Appl. Phys. Lett.* **92** 253501.

LEDS

Dots improve whiteness

Researchers in Singapore have fabricated cool-white LEDs that feature indium-rich InGaN connected-dot nanostructures rather than phosphors.

This switch can improve the color rendering index (CRI) of white LEDs. "The CRI of our device is in excess of 80 due to a larger color gamut arising from a broader spectrum," explained Chua Soo Jin from the Agency for Science, Technology and Research.

White light is produced by combining the output from blue-emitting multiple quantum wells and yellow-emitting quantum dot structures, which are produced in a single MOCVD growth run on sapphire substrates. The yellow-emitting region was formed by deposition of an InGaN wetting layer, before the trimethylindium flow was increased to form indium-rich nanostructures.

LEDs delivered 40 lm/W at 30 mA. "We expect to achieve at least twice that value with improvements in light extraction," said Chua. The researchers are aiming to improve their device's light extraction, optimize the growth process and switch to a low-defect-density GaN template.

Journal reference

C B Soh *et al.* 2008 *Appl. Phys. Lett.* **92** 261909.